

**Excerpt from USEPA's Ecological Soil Screening
Levels for Mn, Interim Final, OSWER Directive
9285.7-71, dated April 2007**



You are here: [EPA Home](#) Eco-SSL

ECO-SSL

The Ecological Soil Screening Level (Eco-SSL) derivation process represents the collaborative effort of a multi-stakeholder workgroup consisting of federal, state, consulting, industry and academic participants led by the U.S. EPA, Office of Emergency and Remedial Response. It is emphasized that the Eco-SSLs are soil screening numbers, and as such are not appropriate for use as cleanup levels. Screening ecotoxicity values are derived to avoid underestimating risk. Requiring a cleanup based solely on Eco-SSL values would not be technically defensible.

The Eco-SSL web site provides an overview of the contaminant. Separate discussion are provided for each receptor group including a comprehensive list of literature evaluated under the effort, and a summary of data used in deriving Eco-SSL values. For each chemical, Eco-SSL documents are provided in a PDF format which requires the [Acrobat Reader](#). For some documents HTML versions are available with linkages to the toxicity data records within the U.S. EPA's [ECOTOX](#) database.

Interim Eco-SSL Documents

METALS

Aluminum [PDF](#) (297KB)
Antimony [PDF](#) (981KB)
Arsenic [PDF](#) (1,725KB)
Barium [PDF](#) (1,238KB)
Beryllium [PDF](#) (1,098KB)
Cadmium [PDF](#) (2,591KB)
Chromium [PDF](#) (2,104KB)
Cobalt [PDF](#) (1,775KB)
Copper [PDF](#) (1,743KB) **UPDATED 2/07**
Iron [PDF](#) (439KB)
Lead [PDF](#) (1,466KB)
Manganese [PDF](#) (1,466KB) **NEW 7/07**
Nickel [PDF](#) (830KB) **NEW 3/07**
Selenium [PDF](#) (1,061KB) **NEW 11/07**
Silver [PDF](#) (652KB) **NEW 9/06**
Vanadium [PDF](#) (1,939KB)
Zinc [PDF](#) (4,857KB) **NEW 11/07**

ORGANICS

DDT and metabolites [PDF](#) (922KB) **NEW 8/07**
Dieldrin [PDF](#) (787KB) **UPDATED 10/07**
Pentachlorophenol [PDF](#) (699KB) **UPDATED 8/07**
Total PAHs [PDF](#) (1,758KB) **NEW 8/07**

Ecological Soil Screening Levels for Manganese Interim Final

OSWER Directive 9285.7-71



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Office of Solid Waste and Emergency Response
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1.0 INTRODUCTION

Ecological Soil Screening Levels (Eco-SSLs) are concentrations of contaminants in soil that are protective of ecological receptors that commonly come into contact with and/or consume biota that live in or on soil. Eco-SSLs are derived separately for four groups of ecological receptors: plants, soil invertebrates, birds, and mammals. As such, these values are presumed to provide adequate protection of terrestrial ecosystems. Eco-SSLs are derived to be protective of the conservative end of the exposure and effects species distribution, and are intended to be applied at the screening stage of an ecological risk assessment. These screening levels should be used to identify the contaminants of potential concern (COPCs) that require further evaluation in the site-specific baseline ecological risk assessment that is completed according to specific guidance (U.S. EPA, 1997, 1998, and 1999). The Eco-SSLs are not designed to be used as cleanup levels and the United States (U.S.) Environmental Protection Agency (EPA) emphasizes that it would be inappropriate to adopt or modify the intended use of these Eco-SSLs as national cleanup standards.

The detailed procedures used to derive Eco-SSL values are described in separate documentation (U.S. EPA, 2003, 2005). The derivation procedures represent the collaborative effort of a multi-stakeholder group consisting of federal, state, consulting, industry, and academic participants led by what is now the U.S. EPA Office of Solid Waste and Emergency Response (OSWER).

This document provides the Eco-SSL values for manganese and the documentation for their derivation. This document provides guidance and is designed to communicate national policy on identifying manganese concentrations in soil that may present an unacceptable ecological risk to terrestrial receptors. The document does not, however, substitute for EPA's statutes or regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, states, or the regulated community, and may not apply to a particular situation based upon the circumstances of the site. EPA may change this guidance in the future, as appropriate. EPA and state personnel may use and accept other technically sound approaches, either on their own initiative, or at the suggestion of potentially responsible parties, or other interested parties. Therefore, interested parties are free to raise questions and objections about the substance of this document and the appropriateness of the application of this document to a particular situation. EPA welcomes public comments on this document at any time and may consider such comments in future revisions of this document.

2.0 SUMMARY OF ECO-SSLs FOR MANGANESE

Manganese is one of the most abundant trace elements in the lithosphere and is widely distributed in the environment in over 100 minerals, including various sulfides, oxides, carbonates, silicates, phosphates, and borates (ATSDR, 1998; HSDB). The most common manganese minerals include pyrolusite (manganese dioxide), romanechite, manganite (manganese (III) oxide), and hausmannite (manganese (II, III) oxide) (ATSDR, 1998; HSDB).

The principal uses of manganese are in the manufacturing of steel and alloys (ferromanganese and copper manganese) (Budvari, 1996; HSDB). Manganese compounds may also be released to the environment through their use in batteries, electrical coils, ceramics, matches, glass, dyes, fertilizers (manganese sulfate), oxidizing agents, antiseptics (potassium permanganate), catalysts (manganous acetate), pesticides (potassium permanganate), pigments (manganese sulfate), antiknock agents (methylcyclopentadienyl manganese tricarbonyl), and as animal food additives (manganese sulfate, manganese carbonate). Other important anthropogenic sources of manganese include industrial emissions, combustion of fossil fuels, and landfills (Klaassen et al., 1995; Pisarczyk, 1995; Lewis, 1997; Reidies, 1990; Ashford, 1994; ATSDR, 1998; HSDB).

Manganese compounds are important soil constituents. In soils, redox reactions affect the sorption of manganese compounds which in turn have a considerable effect on soil properties such as cation exchange (Kabata-Pendias, 1992). Background concentrations reported for many metals in U.S. soils are described in Attachment 1-4 of the Eco-SSL guidance (U.S. EPA, 2003). Typical background concentrations of manganese in U.S. soils are plotted in Figure 2.1 for both eastern and western U.S. soils.

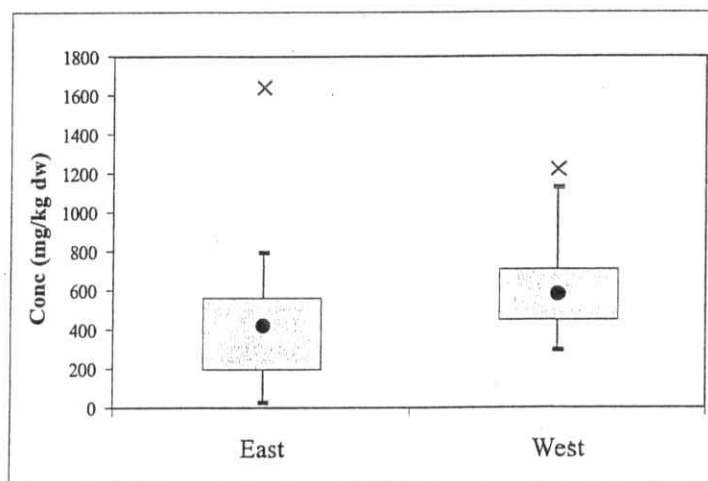
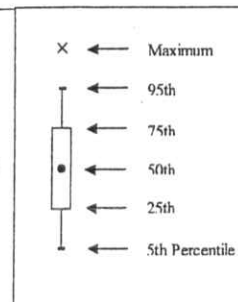


Figure 2.1 Typical Background Concentrations of Manganese in U.S. Soils



Manganese is multi-valent and can exist in the 2+, 3+, 4+, 6+, and 7+ oxidation states, with 2+, 3+, and 4+ being the dominant oxidation states in the environment. Manganese 2+ is the most stable oxidation state in water while manganese 3+ and 4+ compounds are immobile solids. Organic matter may reduce manganese 3+ and 4+ compounds, resulting in the formation of soluble manganese 2+ compounds. Insoluble manganese compounds are formed under aerobic conditions, and soluble compounds are formed under anaerobic conditions from reduction reactions by microorganisms. Soluble manganese compounds are relatively mobile and may leach into surface or ground water (Bodek et al. 1988; HSDB). Soluble manganese is released from soil through ion exchange when replaced by more strongly binding metals such as copper, zinc, or nickel (Bodek et al., 1988;

HSDB). Reducing soil pH and soil aeration increases the solubility of manganese in the soil (WHO 1981; HSDB). In soils, manganese is known to interact with a handful of other elements. Most prominently, manganese is observed to interfere with the availability of cobalt to plants from soils via a strong affinity of manganese oxides to native cobalt. Also, in acidic soils that contain a large amount of manganese, iron absorption by plants can be affected. Interactions also are known to occur between manganese and other heavy metals including cadmium, lead, zinc, and phosphorous (ATSDR, 1998; HSDB).

Manganese is an essential nutrient for both plants and animals. In animals, manganese is associated with growth, normal functioning of the central nervous system, and reproductive function. Specifically, manganese is associated with the formation of connective tissue and bone, carbohydrate and lipid metabolism, and embryonic development of the inner ear (WHO, 1981; HSDB). Manganese deficiency in animals is demonstrated by a reduced growth rate, skeletal abnormalities and abnormal reproductive function (NAP, 1980). Manganese nutritional requirements and typical concentrations in animal feed are discussed in Attachment 4-3 of the Eco-SSL guidance (U.S. EPA, 2003). High levels of manganese may produce neurotoxic responses such as hypoactivity, nervousness, tremors, and ataxia. Other reported effects include liver damage and decreased growth (Clayton and Clayton, 1981-82; 1993-94; Venugopal and Luckey, 1978; HSDB).

Manganese is essential in plant nutrition for the oxidation-reduction process. Specifically, manganese participates in the oxygen-evolving system of photosynthesis and in the photosynthetic electron transport system. In the soluble form, manganese is easily taken up from soils by plants and is rapidly translocated throughout the plant. Manganese deficient plants exhibit decreased growth, interveinal chlorosis, necrotic spots on leaves, and browning of roots. Manganese toxicity is demonstrated in plants by iron chlorosis, leaf puckering, necrotic brown spots, and an uneven distribution of chlorophyll in older leaves (Kabata-Pendias, 1992).

The Eco-SSL values derived to date for manganese are summarized in Table 2.1.

Table 2.1 Manganese Eco-SSLs (mg/kg dry weight in soil)			
Plants	Soil Invertebrates	Wildlife	
		Avian	Mammalian
220	450	4,300	4,000

Eco-SSL values were derived for all receptor groups. The Eco-SSL values for manganese range from 220 mg/kg dry weight (dw) for plants to 4,300 mg/kg dw for avian wildlife. The Eco-SSL for plants is less than the 5th percentile of reported background soil concentrations of manganese in western U.S. soils and less than the 50th percentile for eastern U.S. soils (Figure 2.1). The Eco-SSL for soil invertebrates is less than the 50th percentile for western U.S. soils and less than the 75th percentile for eastern U.S. soils (Figure 2.1). The Eco-SSLs for avian and mammalian wildlife are higher than reported range of background concentrations in both western and eastern U.S. soils.